READ—Annual Report for the year 1904-05, submitted by the Agricultural Chemist to the Government of His Highness the Maharaja of Mysore, with his letter No. 674, dated the 4th December 1905.

No. R. 10787-96—AGRI. 76-05-5, DATED BANGALORE, 17TH FEBRUARY 1906.

ORDER THEREON.—Dr. Lehmann having returned from his furlough in October 1904, the working of the Department was in his hands during the greater part of the official year 1904-05.

2. The work done consisted mainly of plot experiments, analysis of agricultural products, such as, coffee, famine food, and of fertilizers, elaborate investigation into improved methods of sugar manufacture and the imparting of information and advice regarding agricultural matters to the public. This last portion of the Agricultural Chemist's work is said to be steadily increasing, thus indicating a gradual awakening on the part of those engaged in agriculture to the advantages of expert guidance and scientific knowledge.

3. An Agricultural Farm at Hebbal in close proximity to Bangalore was opened during the year, and the necessary buildings are approaching completion. The Agricultural Chemist has made arrangements to therein conduct experiments on a more extensive scale for the purpose of studying the various factors upon which agricultural produce depends, with special reference to the influence exerted by the qualities of the soil, manures, agricultural implements, the mode in which the soil is prepared for agricultural operations and the most advantageous methods of realizing the produce. It is too sanguine to expect valuable results within a short period of time; for the conditions of experiments shall have to be varied as much as possible and the results tested by an extensive series of observations with a view to lessening the influence of unknown causes which constantly vitiate the conclusions arrived at. The Government believe that if the continuity of such experiments is kept in view and careful tabulation of the results made, the Agricultural Chemist will be able to make important contributions to agricultural knowledge.

4. For the purpose of obtaining a greater uniformity in the conditions under which agricultural experiments are carried on, a pot-culture house has been constructed. This is said to be the first contrivance of the kind on an improved scale in India, and Government trust that with the facilities now available, progress in agricultural investigation will be more marked in future.

5. As the sugar locally produced, in spite of the exceptional richness of the sugar-cane used in its manufacture, is not able to maintain its position in the market in competition with imported sugar, the Agricultural Chemist has been devoting special attention to the improvement of the industry. As its unfavourable position is due to defective methods of production, Government have read with great interest the elaborate experiments conducted by the Agricultural Chemist as to the most suitable time for cutting the sugar-cane, the interval within which it should be milled, the boiling and treatment of the juice and the best way of clarifying it. There is no doubt that the cost of production will be materially reduced if the waste of a large quantity of the juice which remains unextracted owing to the crude nature of the mills employed, can be prevented. What is, therefore, urgently required is a cheap and efficient mill. The majority of the consumers being satisfied with jaggory, it is doubtful if the practice of each producer converting the sugar-cane raised by him into jaggory will decrease to any material extent. The use of large mills will be confined, at any rate for some time to come, to such wealthy producers and manufacturers as may carry on the operations on a large scale. The enterprise of the Inamdar of Gorgally, however, who has obtained a loan of Rs. 2,500 from Government to get an improved sugar-cane mill, is commendable, and the Government trust that his example will be widely followed, when the undoubted advantages of adopting improved machinery become manifest by the success of the new mill. The Agricultural Chemist has collected information of great commercial value, and Government hope that the sugar industry will materially benefit by it. It will be useful if this information is embodied in a bulletin and issued for the information of the public with Kannada translation.

6. The experiments conducted by individual planters as to the value of manures in the production of coffee have not led to any conclusive results. Government have recently assisted the planters of the Hassan and Kadur Districts in acquiring suitable lands for a coffee experimental farm in the Belur Taluk on favourable terms, and Government trust that the extended observations to be carried on therein will throw more light on the subject and serve to minimise the cost of production either by demonstrating the inutility of excessive manuring or the precise method of increasing the output. Considering the state of the coffee market, Government agree that anything calculated to help planters to increase their profit, will be of great value to a somewhat languishing industry, and Government desire Dr. Lehmann to heartily co-operat with them in carrying on their experiments.

7. The report contains a great deal of useful information as to the composition of manures and Government note with satisfaction the increasing tendency to obtain guarantees of composition both on the part of merchants and agriculturists. The special attention which has been

paid by the Agricultural Chemist to the possibility of using, as manure, some of the waste products in sugar and other manufactories, and the processes to which they should be subjected beforehand, will, it is hoped, lead to results of considerable commercial and agricultural value. Government would be glad to know the results of the experiments concerning the Lantana ash. In the possibility of its use as a manure lies that of effectually overcoming the noxious effects of the growth of Lantana.

8. It is gratifying to note that the analyses of famine foods are being systematically conducted. A list of the sample of famine foods analysed during the year would have been useful, had it been furnished.

9. The Government of India have sanctioned the appointment of Mr. Coleman as Entomologist and Mycologist to investigate insect pests and fungoid disease. He is now undergoing a post-graduate course to qualify himself specially for the work he will be required to do in the State and is expected to join in 1907. Two new Probationary Chemists out of the candidates trained by the Agricultural Chemist were appointed during the year and two more will be selected next year. The Agricultural Chemist has now a full complement of Assistants with whose assistance he should be able not only to carry out experiments on a more comprehensive scale, but tour about more frequently for studying local conditions of agriculture and advising and influencing the agricultural classes in a greater measure.

10. It is desirable to publish, in future, the Kannada translation of the report along with the English version, so that the results achieved during the year may be known as early as possible before the commencement of the next agricultural season. As the work can be completed during the period intervening the receipt of the English report and its review by the Government, the Agricultural Chemist will make proper arrangements for the purpose in future.

SIXTH ANNUAL REPORT OF THE AGRICULTURAL CHEMIST FOR THE YEAR 1904-05.

PART I.

1. This part of the report which treats of the general working of the Department is not intended for distribution. Part II contains all that is of general interest to the agriculturists of the State.

2. Four of the most important items to be recorded in this year's report are the acquisition of about thirty acres of land at Hebbal to be used for an experimental farm, the appointment of Mr. Leslie C. Coleman to the post of Mycologist and Entomologist, the preparation by very simple methods of an excellent sample of raw sugar, and the erection of a pot-culture house in the Laboratory compound.

3. *Experimental Farm.*—The lands of the Experimental Farm have been laid out into plots of one-tenth acre each and a test crop is being grown on them to record the degree of uniformity (or lack of uniformity) existing between the different lots. The details are given in the second part of this report.

4. *Staff.*—The Agricultural Chemist returned from leave on October 16th, 1904, and took over charge of his Department from Mr. Wetherell after the Dasara holidays. Mr. Leslie C. Coleman, B.A., Gold Medalist of the University of Toronto for the year 1904, has been appointed Mycologist and Entomologist to the Government of His Highness the Maharaja of Mysore in this Department. After one year's post-graduate work in Toronto, he worked for five months in the laboratories of the Department of Agriculture at Washington, and after studying in various laboratories in Europe and the Imperial Department of Agriculture at Pusa is expected to take up his work in Mysore in the early part of the year 1907. The scholars in Analytical Chemistry finished their course of training on the 30th of June 1905, and two of them, Mr. Narasimhaiengar, B.A., and Mr. Sampataiengar, passed the prescribed examinations at the close of the course and were appointed Probationary Assistant Chemists. The third scholar, Mr. Sectaramiah, B.A., failed and reverted to the Educational Department. D. G. Ramachandra Rao, who had been sent for a course of instruction to the Bombay Experimental Farms, has been appointed Superintendent of the Experimental Farm at Hebbal.

5. *Experiments in the Laboratory compound.*—The experiments in the Laboratory compound were very similar to those of last year, though somewhat more valuable. Experiments to test the after-effect of manures gave no indications that any of the manures applied last year had had any effect on this year's crop. Regarding cultivation, the improved ploughs and deep digging again showed beneficial results. Ground-nuts were badly diseased and gave poor returns. Sugar-cane gave very promising returns for a ratoon crop.

6. *Coffee experiments.*—The experiments on Mr. Denne's and Mr. Harris's experimental fields of coffee were continued and confirmed previous results, *viz.*, that for some reason or other the fertilizers applied did not act.

7. *Pot-culture house.*—A pot-culture house, which is so very important when investigating problems in agriculture, is in course of erection.

8. *Out-buildings.*—These and the Laboratory compound wall have been practically completed.

9. *Sugar-boiling experiments.*—The attempts made thus far to make centrifugalled sugar instead of jaggory have been very successful indeed, raw sugar of the very best quality having been produced. It is now highly desirable to make experiments on a larger scale with larger machinery. Experiments regarding the effect of lime on the color of jaggory indicate that liming to a slight alkaline reaction *improves* instead of *spoils* the color of jaggory, while if limed short of this point, an increase of lime darkens the jaggory produced.

10. *Analyses.*—The analytical work consisted in 17 samples of fertilizers; 131 samples of sugar, massecuite, etc., 22 samples of coffee; and 83 other agricultural samples principally famine foods. Two of the Assistants were engaged exclusively on work for the Geological Department; of these Mr. Venkata Rao, B.A., devoted practically all his time to gold analyses. The analyses done for the Geological Department consisted of 32 complete gold analyses, 86 assays of gold and silver, and 11 analyses of rocks and minerals. The principal part of the analyses of agricultural samples are contained in Part II of this report. The analyses done for the Geological Department will be published, if published at all, by the Geological Department.

11. *Correspondence.*—The correspondence which consisted principally in the answering of questions on agricultural problems is increasing and requires a very large portion of the time of the Agricultural Chemist. Nine hundred and thirty-seven letters were received and nine hundred and forty-three were sent out. With this correspondence and the other clerical work required in this Department the clerks are often overcrowded with work and frequently the replies to questions are delayed much longer than should be in an office of this kind. Another item occupying considerable time is the answering of questions set by persons seeking information in person.

12. *Tour to Pusa.*—In December 1904, the Agricultural Chemist started on a tour with the principal object of attending the first meeting of the Board of Agriculture at Pusa. On his way he visited the chemical laboratory connected with Messrs. W. Coen & Co.'s Manure Works at Hubli. This laboratory was built at the suggestion of the Agricultural Chemist and fitted up in consultation with him. Mr. W. Coen, senior member of the firm, had received a short course of training in Nitrogen determination in this laboratory, and the object in visiting the laboratory at Hubli was to see that all was in proper working order and to test the apparatus. The Exhibition at Bombay was visited especially with the object of seeing what agricultural machinery and implements were exhibited. And if that exhibition gives any idea of the implements actually in use or likely to be used soon in Bombay, that Presidency is much further advanced in matters of agricultural implements than I had expected. At Pusa many subjects of interest to agriculture were discussed, but an advantage even greater than this was the meeting and the coming into closer touch with the various men interested in agricultural investigations. Outside of the Pusa staff I was interested in and benefited most by the meeting with Dr. Mann, the Scientific Officer of the Indian Tea Association. On the meetings at Pusa and on the Institute itself a separate report has already been submitted with my letter No. 554, dated 10th February 1905, to the Secretary to the Government of His Highness the Maharaja of Mysore. The same report also contains a statement of the impression received at the Samalkot Sugar-cane Experimental Farm.

13. The only publication issued during the year is the Annual Report of the previous year's work; and of that the Kanarese translation is far from being completed. The translation is being made by the Superintendent of the Experimental Farm who should spend *all* his time on the Farm. It is hoped, however, that this work can in future be done either in the office or by some other Agricultural Assistant.

14. All the Assistants and the subordinates have worked faithfully and well, and my thanks are due to each and every one of them for the cheerful way in which they have done all the work entrusted to them.

PART II.

15. This is the only part of the report intended for distribution. Part I does not contain information of general interest to the agriculturists of Mysore.

EXPERIMENTAL FARM.

16. Some years ago lands were selected for an Experimental Farm by the Agricultural Chemist, and were visited by and approved of at the time by Sir P. N. Krishna Murti and Mr. Mollison. But at the time the plan to open an Experimental Farm fell through. These lands were acquired and handed over to this Department in January 1905. They consist of twenty-one acres and nineteen guntas of dry and garden lands and nine acres and twenty-seven guntas of wet land under the Hebbal tank five miles from Bangalore. The dry land which is almost adjoining the wet area, is lying between the Yelahanka road and the Military reserve just south of the Hebbal tank. It is a ferruginous loam representing, as far as can be judged by the eye, fairly well the average soil of the State. The soil is as uniform as could be found in the neighbourhood of Bangalore, but gradually changes a little from the road to the Military reserve, and from the southern boundary to the tank. It slopes gradually and uniformly towards the tank. Enclosed is a map showing the original fields and the plots as laid out at present. These plots are one-tenth of an acre each, being fifty links wide and two hundred links long. The land was previously owned by several raiyats who have

naturally treated it somewhat differently in regard to manuring and cultivation. The various pieces used as garden lands are of course in much better condition than those used for ordinary dry crops. This causes considerable temporary differences to exist in some of the plots in addition to probably slight permanent differences. These temporary differences, it is hoped, will disappear in the course of a year or two. If any permanent differences exist, they will have to be compensated for by a judicious disposition of the duplicate plots. To get a clear insight into the differences actually existing between the various plots intended for experiments, all the plots were treated exactly alike this year. The crop growing on them is ragi. The grain and straw produced by each plot will of course be weighed separately. And if the results are sufficiently uniform over a sufficiently large part of the area, that area will be used for experiments next year. The remainder will be again placed under uniform treatment. Just what the nature of the experiments will be cannot of course be determined until after the present test crop has been reaped and weighed.

17. A part of the dry lands nearest the tank, which is not quite as uniform as the remainder, is already excluded from the experimental ground proper. On part of this, various garden and field crops have been grown this year. The seeds of most of these were kindly sent by the Bombay Department of Agriculture from the Experimental Farm at Manjri. These crops are doing well on the whole; though some of them, notably one otherwise very promising variety of brinjals, have suffered very much from disease. On an apparently even part of this non-experimental area ragi was sown at various times to get a general impression of the effect the time of sowing has on this crop. In this experiment the rain is of course the most important factor. Sometimes there is enough rain to enable ploughing, but the soil gets too dry by the time the ploughing is finished to permit the grain to germinate. After the next rain some time is again required before the sowing is completed. To test if it would be possible to sow as soon as the ploughing is finished, even if the ground is too dry, and thus permit the crop to get the full benefit of the next shower of rain, was one of the objects of these experiments. In addition to the danger that the seed may germinate and afterwards die for want of moisture, there is the draw-back that if the seed does not germinate, it may be eaten by ants or some other pest. To overcome this the grain was covered by a very thin film of kerosene oil. A little of this oil was poured on a heap of seed grain and this was thoroughly stirred so that each grain although appearing dry had a distinct smell of kerosene oil. To test if this thin coating had any injurious effect on the germination or the future growth of the plants a second plot was sown at the same time with seed not treated in this way. Within a week after the first set of two plots had been sown several good showers of rain fell. The grain treated with kerosene oil came up quite as well as that without it, and as far as appearances go at present the crop on the later sown plots is not likely to be as heavy as on those sown earlier. Next year these experiments will be begun earlier.

18. The so-called experimental area, that on which it is hoped to conduct comparative experiments hereafter, was ploughed twice with a one-horse Canadian plough, and as it was fairly weedy in parts, a Planet Junior horse hoe was used instead of a harrow before seeding. No manure of any kind was applied. But the crop looks very much better than that on the adjoining field which received a dressing of cattle manure and was cultivated in the usual way. To what this very considerable difference is due, it is at present impossible to say.

19. The wet area was also divided into one-tenth acre plots. One range is at a considerably higher level than the remainder and on it the soil is decidedly lighter, being a ferruginous loam not much heavier (or stiffer) than that of the dry area. On this range it is intended to conduct experiments with sugar-cane. The remaining ranges are a clay loam gradually becoming a little heavier towards the north-east. The land is the most south-westerly block under the Hebbal tank and slopes gradually towards the north-eastern corner. Each range and each plot can be irrigated and drained independently of the other. The plots are separated by bunds three feet wide and the top of these bunds serves, as a path. The entire so-called experimental area has been put under the same variety of paddy to test the uniformity of the soil in the same way as has been done for the dry lands with ragi. The accompanying map gives the original sub-divisions of these lands and the present experimental plots. The original differences in levels are also given. Care has been taken to have the present boundaries of the plots coincide as nearly as possible with the boundaries of the former fields, especially where any marked difference existed in the levels of the old fields. Still some re-levelling had to be done, and the effect of this is quite distinctly visible in the crop growing at present. But with the exception of a little filling in, which was necessary in the future sugar-cane range, no earth has been removed from or added to any of the plots. The levelling has been entirely in the plot itself, in fact in each individual one-third or half section of the plot (for all the plots are divided into two or three sections to reduce the amount of levelling required). And the poorer stand due to the removal of part of the surface soil in the higher part of the section is compensated for, to a large extent at least, by the better stand of paddy in the part where this soil has been added. The paddy was all grown in seed beds outside the experimental area and transplanted. Thus far, it has been practically free from disease or insect pests and promises to crop well. Of course no manure of any kind has been used.

20. Temporary buildings have been erected on the Farm which will, it is hoped, last until the permanent buildings which have been sanctioned are built. They are necessarily very small. A rain-gauge, kindly supplied by the Meteorological Department, has been set up, and some other Meteorological instruments such as sunshine recorder, will, it is hoped, be added in time.

LABORATORAY COMPOUND.

Ragi.

21. *Ploughing.*—The experiments with ragi were this year a little more satisfactory than last year. Still the results require to be taken with almost as much reservation as was necessary last year. The crop is better all round, on the manured as well as the unmanured plots. On the unmanured soil the difference in favor of the plot cultivated with the Canadian plough has largely disappeared when compared with the plots ploughed with the native implement. But on the land manured with cattle manure (on which practically no difference existed last year) there is this year a decided difference in favor of the Canadian implement. The plots which received cattle manure and were cultivated with the Mysore plough gave at the rate of 975 lbs. of grain per acre, those ploughed with the Canadian implement gave at the rate of 1,437 lbs. of grain per acre.

22. *Manuring.*—Last year, the cattle manure plots gave at the rate of only thirty-one and one-third pounds of grain for every one hundred lbs. produced by the commercial fertilizer plots. This year, they gave relatively much better returns, producing at the rate of eighty-six and a half lbs. of grain for one hundred lbs. grown on the commercial fertilizer plots, but the amount of commercial fertilizer used contained more plant foot than the cattle manure. Contrary to expectations there was no indication that any of the manures applied last year had any effect on this year's crop, not even the cattle manure. But owing to the uneven nature of the soil, it is impossible to detect slight improvements in crop due to the after-effect of the manures used last year even if they existed. The already small plots manured last year were divided, one-half remained unmanured, the other half was manured as in the previous year. If the soil had been uniform, any after-effect of last year's manures should have been noticed when comparing these half plots which had received manure last year, but not this year with the plots which had received no manure at all. But while two unmanured plots gave exactly the same amount of grain (at the rate of 1,225 lbs. per acre) the other two plots gave decidedly less (357 lbs. and 712 lbs). With such large difference in duplicate plots it is out of the question to attach much weight to any of the results. The average of these four plots is 879 lbs. of grain per acre, that of the six plots manured last year but not this year is just 800. No after-effect of the last year's manures can therefore be deducted. The average of the corresponding manured plots is, however, 1,393 lbs. per acre.

23. One plot which received a double quantity of commercial fertilizer both last year and this year, showed that too much manure had been applied, as it produced a very heavy crop of straw (nearly five and a half tons per acre) and practically no grain (595 lbs. per acre). The average of the plots dug deep (about two feet) was:—unmanured 1,212 lbs. per acre, manured with commercial fertilizers 1,475 lbs. Apparently ragi favors deep cultivation. But of course all these experiments are only preliminary and conducted on much too small a scale and on too uneven a soil to carry any weight except as indications for future experiments on the Experimental Farm.

24. The maximum crop for the variety of ragi (Halubile) used in this experiments appears for this season, on this soil, to have been about one ton of grain (2,225 lbs.) and a little over five tons of straw (11,375 lbs.) per acre.

25. The variety giving best returns this year was Balepatte, which produced at the rate of about one and two-thirds tons (3,750 lbs.) per acre of grain and nearly six and one-fourth tons (13,800 lbs.) of straw. This variety stood second last year, and the variety which headed the list last year, Jenumuddina ragi, stood third this year. But here too the plots are too small, and possibly too uneven, to draw any reliable conclusions. The crops are, however, very heavy for all the varieties. There is also an indication that the Madayangiri and the Dodda varieties would do relatively better when treated not as liberally as these plots have been treated.

26. *Sweet potatoes.*—The sweet potatoes did not do quite as well as in the previous year. The new Jersey gave exactly the same yield as the year before (at the rate of 14,175 lbs. per acre) and headed the list instead of being second as last year. The Virginia and the Nansimond gave at the rate of 8,600 lbs. and 8,760 lbs. per acre this year.

27. *Ground-nuts.*—The ground-nuts were all badly diseased this year. The Virginia instead of heading the list as it did last year with 10,100 lbs. per acre came last with only 3,550 lbs. per acre. The Japanese gave 4,100 lbs. instead of 8,750 last year, and the Pondicherry, 4,550 instead of 6,925 last year. The relative positions are therefore exactly reverse to those of the previous year. But of course, when diseased as they were this time, the returns would be of little value even if the soil had been absolutely uniform. The same seed will be sown next year, but that used for one-half the plot will be treated for five minutes with a one per cent solution of copper sulphate to see if such treatment will reduce the disease.

28. *Buildings.*—The out-buildings containing store rooms, implement rooms, godowns for two servants, and a potting room for the pot-culture house are practically completed. A pot-culture house is in course of construction. This is an iron structure which is to be covered on all sides with wire netting

Pot-culture house.

to keep out birds and other small animals which cannot pass through a half-inch mesh. In this pot-culture house will be a light railway track on which small cars can be run. On these cars will be the pots in which the various experiments are made. They are placed on cars so that at times of heavy rains or winds they can be easily run under shelter and at times when there is no danger from birds or other small animals they can be run out into on open yard if such should be desirable. Pot-cultures are quite a new line of experiments for India, or, as far as I know, any other tropical country. Dr. Leather has tried them on a small scale at Dehra Dun last year without a railway track and cars, but found that these appliances are necessary for satisfactory work. It is, at present, impossible to say what kind of shelter will be required here. In Europe and America these shelters are constructed of glass. But it appears likely that such would not answer under a tropical sun. As an experiment, the potting room in the new out-buildings will be used, to begin with, as a shelter for the plants. By replacing some of the ordinary tiles in the roof of this potting room by glass ones it may be possible to get enough light without getting too much heat. After finding out what is likely to answer for this purpose in this climate, it is hoped that the necessary changes or additions can be easily made.

29. In pot-cultures, the soil is all thoroughly mixed before being filled into the pots and thus the inaccuracies arising from an uneven soil are to a very large extent done away with. The other advantages and disadvantages will be explained after the completion of the house and after some work has been actually done in it.

30. *Compound wall.*—The compound wall protecting the small experimental plots in the Laboratory compound is also practically completed.

SUGAR AND SUGAR-CANE.

31. The experiments conducted with sugar-cane were this year confined almost exclusively to the manufacturing side of the sugar industry. Chief of these were the manufacture of raw centrifugal sugar, the determination of the amount of juice left in the cane when milled, as carefully as possible, with a local, three roller, iron bullock mill, and determining the extent of loss sustained by keeping the juice after being milled or the cane after being cut.

32. *Ratoon crop.*—The cane for these experiments was grown in the laboratory compound from the stubble of last year's crop. It is therefore a ratoon crop. The reasons for doing this were many; one of the chief of these was to see how a ratoon crop would grow here, and to find out if there were any very sound or strong reasons for not following in India the general practice of Cuba and other cane-sugar-producing countries. Some of the other reasons were—

(*a*) to get, if possible, the next crop in a little over a year's time, the variety grown was, as stated last year, one of the so-called eighteen months varieties;

(*b*) to avoid the necessity of planting the cane without the supervision of the Agricultural Chemist who was on leave, and incidentally

(*c*) to save the expense of planting.

The previous crop was cut in the latter part of March 1904. The ground was thoroughly dug and manured as in the previous year. Surface irrigation was given whenever necessary. The ratoon crop came up well. As far as could be judged by the eye, there were a larger number of stalks but shorter, thinner and shorter jointed. The white ants did quite as much, if not more, damage than in the previous year. The cane was wrapped as had been done the year before, but notwithstanding this and the fact that the canes were shorter, it did not appear to stand as errect at the time of cutting as the crop before it had done. But as one season's crop cannot be closely compared with an other produced the year before or the year after, these differences as well as the difference in yield can only be taken as indications. They are not experiments and only serve as indications for future experiments. Moreover actual field experiments, no matter how carefully conducted have to be repeated a large number of times before the results obtained can be considered as reliable. When stating, therefore, that this year's ratoon crop was almost exactly three-fourths of the crop produced last year, this does not imply that on this identical piece of ground this particular variety of cane will give as a first ratoon crop three-fourths of the crop it would have given if it had been planted out that season. But it indicated that it is well worth trying experiments with ratoon crops, especially as in this case the difference in the weight of the cane is to a large extent compensated for by the difference in time the "crop" has been occupying the land. The amount of juice obtained from one hundred lbs. of cane was very little more in 1903-04, than it was this year from the ratoon cane; being 67·64 lbs. in 1903-04 and 65·3 lbs. this year from the ratoon crop. The difference in the two years' crop is also influenced to some extent by the fact that this year about one-fourth of the field was purposely allowed to get over-ripe to see what influence this would have upon the composition of the cane and the quantity of the jaggery (or the sugar) boiled from the juice. During these three months probably very little growth took place, but a lot of the canes were destroyed by white ants, and possibly also by rats.

33. *Ripening of Cane.*—To find out when the cane was ready to be cut, and, more particularly, to study the difference in the composition of the cane during the latter stages of its growth, six average canes were cut at different times and analysed. The first sample was taken on January 22nd. To form some idea of the differences which existed in the more mature and the younger canes on the same plot on the same date, three samples of six canes each were taken on that day. One of these samples represented, as nearly as possible, the average of the plot; another, canes which were slightly below the average, and the third was composed of six canes above the average. The composition of the juice of these three samples of cane and that of the juice of the succeeding samples is given, together with the date on which these samples were taken, in the following table No. I :—

TABLE No. I.

Showing composition of juice of canes at various stages of growth.
Ratoon cane—previous crop cut in April 1904.

No.	Date of cutting			Glucose per cent	Sucrose per cent	Total solids per cent	Remarks
270	22	XI	04	3·04	9·5	12·8	From six canes below the average.
269		Do		2·47	10·1	13·4	From six canes of the average.
271		Do		2·17	11·75	14·6	From six canes above the average.
272	6	XII	04	1·33	14·1	16·0	From six average cane.
273	22	XII	04	1·33	14·95	17·0	Do
274	4	I	05	1·16	16·5	18·3	Do
275	18	I	05	·85	18·4	19·5	Do
276	31	I	05	·93	18·2	19·6	Do
277	14	II	05	·69	19·6	20·9	Do
278	21	II	05	·62	19·5	20·9	Do
279	28	II	05	·53	20·0	21·0	Do
280	21	III	05	·40	21·4	22·4	Do
281	1	IV	05	·54	19·6	20·9	Entire plot.
302	8	IV	05	·70	19·8	21·1	Do
318	17	IV	05	·67	18·4	19·8	Do
340	26	IV	05	·54	...	...	Do
362	9	V	05	·37	..	...	
363	19	V	05	·32	17·5	18·0	
364	26	V	05	·47	17·5	18·8	
365	3	VI	05	·31	16·0	17·0	
366	10	VI	05	1·00	14·9	16·2	
367	17	VI	05	·65	15·6	16·8	
368	24	VI	05	·55	16·0	17·3	
369	1	VII	05	·56	16·0	17·6	

In the above table samples up to No. 280, inclusive, were taken as described above. These show very clearly the decrease in the percentage of glucose and the increase in total solids and sucrose, or cane sugar, in the process of ripening. (Glucose or reducing sugar is a name given to a group of substances which, if present in jaggory, cause it to run or sweat in damp weather in proportion to the amount in which they are present, and are very objectionable from a sugar refiner's point of view. Sucrose, or cane-sugar, is the principal substance next to water found in the juice of sugar-cane. Pure white refined loaf sugar contains practically nothing but this kind of sugar. It is the only substance in sugar-cane which is really wanted. The more of this and the less of every other substance the sugar-cane contains, the better it is, other things being equal, for sugar-making. The total solids mentioned above include everything but the water found in the sugar-cane juice. The nearer the figure given in this column agrees with the figure given in the column headed Sucrose the better). The uniformity of the decrease of glucose and increase of sucrose and total solids as shown in the table above is surprising, considering the difficulties there are in taking representative samples. But when comparing these figures with samples Nos. 281, 302 and 318, which were taken when milling the entire crop, it is evident that the samples No. 280 and those preceding it, though very well taken, are a little

above the average. Samples No. 363 and those following it were taken two months or more after No. 280 (which is the best sample in the list). These samples are more striking in their decrease in cane-sugar and total solids than in their increase in glucose. This is especially worthy of consideration when noting the composition of the juice extracted when the entire crop of the cane was being harvested. But to this point I shall have to refer again later on. The only sample in which there appears to be a considerable increase in the Glucose is No. 366. As it contains one per cent of this substance or nearly twice as much as any of the other samples under consideration, there is evidently something wrong here. It may have been that this sample was not as promptly milled after the cane was cut as the other samples were. But this is a mere conjecture which is based on the results of some other work. There is no direct indication of any kind to prove that this conjecture is correct.

34. *Boiling of jaggory.*—The chief object of this year's sugar-cane experiments was, as stated before, to produce a raw centrifugal sugar. But as a hand centrifugal is very hard to work and as the centrifugal used this year was made for general laboratory work and not specially for sugar-making, the larger part of the juice was again boiled to jaggory. In the tables given below, the composition of the juice is given first and below it the composition of the jaggory produced. All the liming done was tested with red litmus paper. In the samples marked "fully" limed, slaked lime of the consistency of cream or very thin gruel (canji) was added to the entire mass of the juice intended to be boiled into jaggory. After a little of this slaked lime had been added, the juice was thoroughly stirred and a piece of red litmus paper held into the juice for nearly half a minute. If no change took place in the colour of the litmus paper other than that which would be produced if it were dipped into unlimed juice, more lime was added, again stirred thoroughly and tested with the litmus paper. This was repeated until a faint but *distinct* change of colour could be seen in the colour of the litmus paper by the red having changed into a faint blue. The slight difference in the appearance of the litmus paper caused by the colouring matter in the juice must not be mistaken for this change of colour of the litmus itself when juice is sufficiently limed. To avoid such a mistake, it is necessary to learn by experience the effect produced by dipping a piece of red litmus paper into unlimed juice and to learn to distinguish this from the change produced when just enough lime has been added. Care must also be taken that the litmus paper is fresh and not already partially discoloured by having come into contact with anything containing alkali before use. It must not have the slightest tinge of blue but be quite decidedly red. In the samples marked "half" lime, all the juice required for the boiling was thoroughly mixed, half this quantity was poured into the pan before liming, the remaining half was limed as described for full lining and afterwards also poured into the pan and mixed with the portion previously in the pan before boiling. "Three-quarter" limed means that one-quarter of the juice was poured into the pan and the remaining three-quarters limed as above; and in those marked "quarter" limed, only one-fourth of the total juice required for boiling was limed as already described.

Liming.

35. *Pan used.*—To prevent the discolouration of the first samples of jaggory from the rust of an iron pan, a copper pan was used this year. It had the ordinary shape used by the raiyats of Mysore and was six feet in diameter at the top, three and a half feet at the bottom and thirteen inches deep.

36. *Furnace.*—The furnace was in the corner of one of the rooms in the new out-buildings of the Laboratory and had proper fire bars, furnace doors, ash pit and chimney. But has no experiments were made in regard to the fuel required, these and some other improvements need not be considered here.

37. *Filtering.*—Before liming, all the juice was passed through a piece of ordinary "long cloth" placed in a basket of wire netting to separate from it all little bits of cane and other suspended matter. And just before the juice came to a boil the scum which had risen to the surface and is technically known as the "blanket" was skimmed off by means of a large copper spoon with a long handle specially made for the purpose. This scum was put in another basket of wire netting lined on the inside with a piece of "long cloth." Through this the juice gradually dripped out and the bulk of the scum remained behind. The skimming was continued from time to time until the juice had been boiled down to nearly half its bulk. On the average 1·82 oz. of scum were removed for each 100 lbs. of juice boiled and 3·12 oz. of foreign matter were removed by straining the juice before liming for *the same* quantity of juice. On the whole this amounts to very nearly one and a half pounds of foreign matter, or dirt, removed for every 100 lbs. of jaggory boiled, for it took between four and five pounds of juice to produce one pound of jaggory. Of course if the skimmings are not placed on some suitable filter such as a piece of "long cloth" and the juice, which is inevitably removed when skimming, is not saved, the loss will be very great. On the other hand, if an attempt is made to separate the scum from the juice removed with it by either using, as it generally done, a perforated skimmer, or by putting the skimmings into an ordinary basket and letting that which passes through the meshes of the basket run back into the pan, the greater part of the scum is simply broken up and returned to the juice and the attempt to remove the scum has very little practical result. The filter cloths must of course be carefully washed and dried each time they have been used, and on the score of cleanliness *no* wooden baskets should be used.

Removing of scum.

TABLE No. II.

Jaggory boiled from juice fully limed.

No.	Substance	How limed	Sucrose	Glucose	Total solids	Weight of juice required for 100 lbs. of jaggory	Glucose formed during boiling	Colour: Lovibonds' Tintometer: Yellow	Colour: Lovibonds' Tintometer: Red	Colour: Imperial	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
281	Juice from Plot I A	Fully	19·60	0·54	20·9	...	...	...	...	...	
282	Jaggory boiled from 281	Do	91·40	2·30	..	514	0·00	...	...	...	
289	Juice from Plot I C	Do	19·05	0·59	20·2	...	...	...	...	...	
290	Jaggory from 289	Do	87·90	2·99	...	521	0·73	...	...	56	
296	Juic from Plot I E	Do	18·90	0·48	19·9	...	...	...	..	...	
297	Jaggory from 296	Do	82·90	3·78	...	524	1·67	...	...	91	
298	Juice from Plot I E	Do	19·40	0·57	20·6	...	..	..	...	...	
299	Jaggory from 298	Do	85·15	2·80	...	640	0·30	...	...	55	Badly charged
302	Juice Plot I F	Do	19·80	0·70	21·1	...	...	...	...	...	
303	Jaggory from 302	Do	1·60	4·30	...	528	1·42	15	3·1	102	
309	Juice Plot I H	Do	19·35	0·65	20·7	...	..	...	...	...	
310	Jaggory from 309	Do	84·70	3·50	...	512	0·66	...	...	81	
311	Juice Plot J H	Do	19·05	1·00	20·8	...	...	...	...	...	
312	Jaggory from 311	Do	81·80	5·26	...	...	0·97	...	...	104	

TABLE No. II—*concld.*

No.	Substance	How limed	Sucrose	Glucose	Total solids	Weight of juice required for 100 lbs. of jaggery	Glucose formed during boiling	Colour: Lovibonds' Tintometer: Yellow	Colour: Lovibonds' Tintometer: Red	Colour: Imperical	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
313	Juice (Cheni)	Fully	15·70	0·96	17·9	...	...	...	...	..	
314	Jaggery from 313	Do	71·00	11·90	...	...	6·56	13·2	2·4	101	
316	Juice mixed lot	Do	17·60	1·80	20·6	...	...	...	...	...	Some of the canes had been lying for three days before milling. *Charred.
317	Jaggery from 316	Do	75·80	8·47	..	...	3·36	27	7·5	38*	
318	Juice Plot II B	Do	18·40	0·67	19·8	..	...	...	...	...	
321	Jaggery from 318	Do	83·40	3·70	...	...	0·66	22	5·1	69	
322	Juice Plot II B	Do	19·05	0·80	20·4	...	..	...	...	...	
323	Jaggery from 322	Do	81·75	6·30	...	...	2·87	..	..	92	
399	Juice Plot II G	Do	15·59	1·02	17·4	..	...	...	...	...	No. 399 and following cut three months later than the others.
400	Jaggery from 399	Do	72·60	6·85	...	...	1·65	...	..	...	
401	Juice Plot III A and B	Do	15·47	0·99	17·5	...		...	...	...	
402	Jaggery from 401	Do	77·45	8·47	...	...	3·52	17	3·7	35	
403	Juice from Plot III C and D	Do	15·80	0·82	17·9	...	...	...	...		
404	Jaggery from 403	Do	81·90	4·80	..	...	0·55	22	5·4	58	
405	Juice from Plot III E and F	Do	15·50	0·88	17·1	...	...	...	...	...	
406	Jaggery from 405	Do	76·40	9·30	...	...	4·96	13	3·1	100	
332	Juice from Plot II D	Overlimed	18·10	0·73	19·0	...	...	...	...	...	
335	Jaggery from 332	Do	85·30	3·70	..	...	0·26	...	..	60	
336	Juice Plot II D	Do	17·35	0·86	18·6	...	..	...	..	...	
337	Jaggery from 336	Do	81·80	3·80	...	...	0·00	..	...	46	

TABLE No. III.

Jaggory boiled from juice partially limed.

No.	Substance	How limed	Sucrose	Glucose	Total solids	Weight of juice required for 100 lbs. of jaggory	Glucose formed during boiling	Colour: Lovibonds' Tintometer: Yellow	Colour: Lovibonds' Tintometer: Red	Colour: Imperial	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
287	Juice (mixed lot)	Three-quarters	19·40	0·79	20·7	...	...	...	...	...	
288	Jaggory from 287	Do	82·80	4·27	...	491	1·10	...	...	70	
294	Juice (mixed lot)	Do	18·30	0·77	20·6	...	...	...	...	...	
295	Jaggory from 294	Do	81·30	5·80	...	534	2·36	...	...	91	
300	Juice Plot I E	Do.	19·50	0·85	21·0	...	..	...	...	...	
301	Jaggory from 300	Do	83·10	3·90	...	491	0·15	...	...	70	
304	Juice (mixed lot)	Do	19·50	0·69	20·9	...	...	...	...	...	
305	Jaggory from 304	Do	10·65	4·80	...	547	1·88	...	...	65	
407	Juice from Plot III G & G	Do	16·15	0·90	18·5	...	...	...	...	...	
408	Jaggory from 407	Do	80·50	5·40	...	..	0·92	...	...	...	
409	Juice from Plots I & J	Do	16·05	0·95	18·1	...	...	...	...	...	
410	Jaggory from 409	Do	77·45	8·70	...	...	4·12	19	39	70	
283	Juice from Plot I B	Half-limed ...	19·80	0·80	21·0	...	..	...	...	...	
284	Jaggory from 283	Do	85·50	4·03	...	584	1·44	...	...	72	
307	Juice from Plot I G	Do	18·30	0·90	20·1	...	...	...	...	...	
308	Jaggory from 307	Do	75·90	6·49	...	551	2·61	...	...	70	
292	Juice from Plot I D	Quarter-limed	18·70	0·62	19·6	...	..	...	...	...	
293	Jaggory from 292	Do	80·10	6·80	...	400	4·09	...	...	103	

Note.—(1) 25 Grams of juggory dissolved in 500 C. C. of water. The figures in column 10 indicate the depth in millimetres of columns of these solutions having the same colour.
(2) The shade of colour was determined in a 2" cell.

38. *Glucose in juice.*—The glucose in the juice is higher than was expected when starting the milling of the cane. For as sample No. 280, taken before milling began, contained less than half per cent, it was hoped that, as time went on, the glucose would drop still lower than that figure, as it actually did in some cases, but the average is decidedly above half per cent. Why this is the case requires further inquiry. It may be that the canes were not milled as soon as should have been done after being cut. It may be that canes which had been killed by white ants but still looked fresh were not carefully enough excluded, or it may be due to some other unknown or unsuspected cause.

39. *Glucose formed during boiling.*—The amount of glucose formed during boiling is also peculiar and inexplicable at present. When leaving out samples Nos. 399 and those following it which (as they were over-ripe, as considerable glucose formed during boiling and as they were nearly all fully limed) it would not be right to include, and No. 314 which is also evidently abnormal, the average per cent of glucose formed during boiling in the samples fully limed was 1·17%. In the three-quarter limed samples 1·37% of glucose was formed in this way, and in the half-limed sample and quarter-limed samples 2·02% and 4·09%, respectively, of glucose were formed in this way. But as the amount of glucose formed during boiling varied in the fully limed samples from nothing to 3·36%, it is evident that some other causes than the extent of liming were at work and that these figures do not indicate simply differences due to liming. The sample in which 3·36% of glucose was formed during boiling was badly charred; but as in the only other sample which was badly charred only 0·3% of glucose was formed in this way, the charring cannot be the only or chief cause of this glucose formation. If the fact that part of the cane used for this jaggory No. 317 had been cut three days before being milled had any thing to do with this abnormal glucose formation, I cannot say. But I shall make experiments in that direction as soon as circumstances permit.

40. *Colour.*— In order to be able to give a numerical value to the depth of colour of the various jaggories, it was decided to dissolve 50 grams (nearly 4½ tolas) of the jaggory in one liter (a little less than a quarter) of water. These solutions were filtered to remove all suspended matter and filled into glass tubes to such a height that the colours in all the tubes were of the same depth. The lighter the colour of the jaggory the thicker of course the layer of this solution had to be to match the depth of the colour of the other solutions of jaggory. The thickness of these layers or the height to which these tubes had to be filled to match each other in colours, were measured and are given in column No. 11 in the tables No. II and No. III above. The higher this number the lighter the colour of jaggory. A popular belief is that jaggories produced from juices which are "heavily" limed are darker, in proportion to the amount of lime added to the juice, than jaggories boiled from juice to which less lime has been added. When studying this problem we must exclude jaggories Nos. 299 and 317 as these were badly charred when boiled and had therefore a much darker colour than would be due to the lime added to the juice. Possibly some of the other samples of jaggory were also slightly charred, and this may account for the comparatively great variations which exist between jaggories apparently treated alike; but if any of the others have been charred, it was not enough to be easily detected. The average of the depth of colours of the jaggories "fully" limed is 81, and leaving out sample No. 314 which was very light in colour but which behaved peculiarly as far as the glucose is concerned, the average is still very nearly 80. The average of the three-quarter limed jaggory is 61 and the half-limed lot had an average of 71. The "fully" and "overlimed" jaggories (for the significance of these terms refer to page 9) were therefore those having the lightest colour, while those limed nearly but not quite to neutrality (the three-quarter limed lot) were the darkest and the half-limed lots were intermediate to the other two. The quarter-limed jaggory is left out of consideration as there was only one of these. These figures confirm last year's impressions as given in para 24, page 8, of the 5th Annual Report of this Department. The colour of the jaggory appears to behave very much in the same way as the colour of the juice of sugar-cane. The more lime is added to this the darker it gets until it is fully neutralised and becomes alkaline in reaction when the colour becomes very much lighter than it was before reaching neutrality. The raiyats who do not lime their juice *sufficiently* are therefore right in their opinion that the jaggory becomes darker in colour the more lime is added. *But if they add all the lime which is really required, the jaggory will have a brighter colour than that which is now produced,* and in addition it will be of much better quality. *That is if the experiments made in the Laboratory compound which has a very light red coloured soil, apply to the State as a whole,* and I have no reason to believe that they do not do so.

41. In columns 9 and 10 of the above table are given the results obtained with the Lovibond Tintometer on the solutions mentioned above, *viz.*, 50 grams in one liter. A two-inch cell was used. But these figures, though very valuable in giving a permanent record of the actual colours, are not of much interest except to those using this particular instrument. And as every one using that instrument will understand them without further explanation, no further comments are needed.

SUGARS.

42. A large and greatly increasing quantity of sugar is being imported to India every year. In 1893-94 this quantity was a little over 106,000 tons. Five years later the import had nearly doubled, being nearly 204,000 tons; and last year it was a little over 290,000 tons, which is an increase of over 42% in these last five years. This import amounts to nearly 2 lbs.

per head of population, and must represent a very considerable part of the total sugar consumption of India. These imports now come chiefly from Mauritius and Java, and less than 27,000 tons came last year from beet-sugar-producing countries. That such a large and increasing import of sugar takes place shows conclusively that there is something radically wrong with the Indian sugar industry. As far as Mysore is concerned, this "something" is certainly not to be found in the quality of the cane. For I know of no other country in the world in which sugar-cane is grown which contains 20 and 21% of sucrose as it does in Mysore at times. The quantity of cane per acre should of course be improved. But probably there is no part of the industry which requires greater improvement than the manufacturing side. The milling of the cane, the liming, the removal of scum when boiling and the guarding against loss from fermentation of the juice are factors which require careful attention. But as the sugar imported is either refined or goes to the Indian refineries to be refined before being placed on the retail market, it is evident that in order to compete with this imported sugar we must treat our cane juice in such a way as to produce in the most economic way high grades of sugar. And we are unable to do this as long as we produce jaggory first and send that to the factories to be refined. The fuel used to boil down the juice to jaggory is practically wasted, and the char filters and other parts of the refineries are given infinitely more work than need be if the molasses is not removed from the sugar before the latter is refined. Moreover the best grades of raw, centrifugalled sugar manufactured in the districts could be of a sufficiently high quality to be able to replace directly a part of the imported sugar. Jaggory would be unable to do this. As the universal experience is that refined sugars gradually replace the lower grades of sugars in the market, it is self-evident that as long as jaggory continues to be the chief product of the sugar-cane, the sugar industry is bound to decline unless a jaggory can be manufactured which is eminently suited for refining purposes. And as, for the reasons given above, this is not likely to be the case, it is necessary to replace jaggory boiling by more modern methods and to produce as good a quality of raw sugar as the circumstances will permit if the imported sugar is to be replaced in the Indian market by that produced in the country. India is the home of the sugar industry, and when sugar was first imported into Europe it was known by the name of "Indian salt." But the methods which were eminently successful 700 years, or even 150 years ago, cannot compete with modern applicances in an industry in which such advancement has been made as in sugar-boiling. Sugar has dropped very much in price. When first imported in large quantities into Europe it was sold for a price considerably over Re. 1 per pound. In fact only about 100 years ago it was sold, for a short time, for well over Rs. 2 per pound on the continent of Europe; but this excessively high price was due to great restrictions having been placed on trade with sugar in continental Europe. The present comparatively very low price is in a great measure due to better and cheaper methods of production, and in order to compete even in our own markets with countries employing these cheaper and better methods of productions, we must improve our own methods. If their methods are not applicable here we must make our own improvements; but improvements we must make if we want to keep a sugar industry. It is with a view of finding in how far we can adopt some of the improvements made elsewhere, without completely upsetting our existing industry, that the following experiments were made:—

43. The juice was treated exactly as described under the head of jaggory-boiling, but the boiling was not carried on quite as far, being stopped when the condensed juice on cooling formed a mass of about the consistency of thick mud. Experience alone can tell when the boiling has been carried on far enough, but a good jaggory-boiler will very soon learn this. We had not the slightest trouble in this respect. This mass called Massecuite was allowed to stand for three or four days, or longer if more convenient to do so. It was then thoroughly mixed, all hard lumps broken up and put into a small centrifugal in which the molasses was separated from the sugar. In the table below are given the composition of the juice and the Massecuite, and the sugar and molasses separated from it. The molasses was boiled a second time, and the amount of so-called second sugars separated from this molasses is also given.

TABLE

Serial No.	Substance	Weight of water (lbs.) used per 100 lbs. of sugar for washing in centrifugal	Percentage of sucrose	Percentage of glucose	Percentage of total solids	Moisture
1	2	3	4	5	6	7
306	Juice from Plot I G	.....	19·55	0·91	21·3	...
378	Massecuite boiled from above 306	...	74·85	6·30	...	...
379	(a) Sugar made from 378	Unwashed	95·60	1·20	...	1·99
380	(a) Molasses separated from 379	.....	49·70	12·80	...	...
381	(b) Sugar do 378	Unwashed	94·00	1.50	...	3·06
382	(c) Molasses do 381	... ..	49·60	12·80	...	...
383	(d) Sugar do 378	Unwashed	94·70	1·30	...	2·08
384	(e) Do do 378	5·12	97·50	0·68	...	1·80
324	Juice from Plot II C	.....	18·10	0·80	19·6	...
385	Massecuite boiled from 324	... ..	78·20	4·46	...	...
387	(a) Sugar separated from 385	4·45	95·00	1·00	..	2·88
388	(b) Do 385	Unwashed	94·40	1·32	...	2·66
391	(c) Do 385	4·61	95·90	1·12	...	2·30
329	Juice from Plot II C	... ..	18·00	1·16	19·9	...
389	Massecuite boiled from 329	.....	76·90	6·25	...	...
390	(a) Sugar separated from 389	Unwashed	95·20	1·57	...	1·90
392	(b) Do 389	Do ...	94·90	1·74	...	1·50
331	Juice from Plot II C	.. ...	17·40	0·86	18·9	...
370	(a) Massecuite boiled from 331	.....	80·25	4·63	...	...
371	Sugar separated from 370	7·48	98·10	0·45	...	·26
372	Do 370	7·48	98·50	0·40	...	...
373	(b) Massecuite boiled from 331	.....	81·20	4·46	...	...
374	Sugar separated from 373	Unwashed	97·40	0·80	...	·43
375	Do do 373	Do ...	97·10	1·00	...	·49
376	Molasses do 375	.....	53·50	10·20	...	...
377	Sugar do 373	2·31	98·00	0·80	...	·35
393	Sugar separated out of a mixture of all the molasses on standing.	.. ...	86·00	4·06	...	...
397	Juice from Plot II F	.....	15·50	1·05	17·7	...
398	Massecuite boiled from 397	.....	73·35	9·40	...	...
459	Sugar separated from 398	Unwashed	96·50	3·70	...	...
461	Molasses do 459	.....	46·50	18·50	...	...
460	Sugar do 398	Unwashed	89·95	3·70	...	...
462	Molasses do 460	..	45·10	20·30	...	...
394	Molasses out of which 393 was separated ...	... ..	53·75	12·50	...	...
452	Massecuite boiled from 394 (2)	... ..	59 50	13·50	...	...
453	Sugar separated out of 452	Unwashed	86·50	5·1	...	...
456	Molasses separated from 453	.....	32·30	27·7	...	...
454	Sugar separated out of 452	Unwashed	87·00	5·2	...	...
457	Molasses separated from 455	.....	31·70	27·7	...	...
455	Sugar separated out of 452	Unwshed	85·90	5·3	...	...
	Average of all jaggories in the next table	.. ...	81·63	5·48	...	...
	Average of sugars in this table	... ..	95·50	1·39	...	...

NOTE—(1) Calculated on amount of Molasses.
,, (2) 100 lbs. of Molasses gave 87·7 lbs. of Massecuite.

No. IV.—*Sugars.*

Percentage of first sugars calculated on first massecuite	Percentage of first sugars calculated on first massecuite before being washed	Percentage of second sugars calculated on weight of first massecuite	Percentage of total sugar calculated on weight of first massecuite	Pounds of centrifugalled sugar obtained from weight of juice giving 100 lbs. jaggory	Colour: Lovibond's Tintometer: Yellow	Colour: Lovibond's Tintometer: Red	Colour: Imperial	Remarks	Serial No.
8	9	10	11	12	13	14	15	16	17
...	...	...	...	...	...	...	...		306
...	...	...	...	...	...	...	...		378
60·1	...	17·1	77·2	82·5	18	3·3	80		379
...	...	...	...	...	...	...	...		380
62·0	...	16·3	78·3	83·7	18	4·3	75	Belt broke.	681
...	...	...	...	...	...	...	...		382
61·8	...	16·4	78·2	83·6	18	3·7	72		383
58·6	64·02	17·8	76·4	81·7	7	1·8	152		384
...	...	...	...	...	...	...	...		324
...	...	...	..	..	...	...	...		385
62·53	67·3	16·1	78·63	83·8	25	5·1	55		387
66·37	...	14·4	80·77	86·4	60	7·7	35		388
63·68	69·7	15·6	79·28	...	24	4·4	45		391
...	...	...	...	...	...	...	...		329
...	...	...	...	...	...	...	...		389
61·97	...	16·3	78·27	84·7	18	4·5	65		390
64·60	...	15·2	79·8	85·6	67	6·0	42		392
...	...	...	...	...	...	..	..		331
...	...	..	...	...	...	...	...		370
56·8	58·0	18·5	75·3	80·5	18	3·7	80	Coarse.	371
56·8	...	18·5	75·3	80·5	14	3·2	87	Fine.	372
...	...	..	...	...	...	...	...		373
...	...	...	...	...	25	5·7	50	Coarse.	374
86·00	...	13·7	81·7	87·3	25	5·9	50	Fine.	375
...	...	...	...	...	...	...	...		376
63·5 (1)	68·87	15·7	79·2	84·6	20	4·6	63		377
4·02	..	...		...	...	.	...		393
...	...	...	..	...	...	...	...		397
...	...	...	...	...	...	...	..		498
62·3	...	16·2	78·5	83·9	73	11	34		459
...	...	...	...	...	...	...	...		461
63·3	...	15·7	79·0	84·4	74	11	32		460
...	...	...	...	...	...	...	...		402
...	...	..	...	...	..	...	...		394
...	...	..	...	...	...	...	...		452
...	...	46·9	...	...	168	24	8		453
...	...	...	...	...	...	...	..		456
...	...	47·4	...	...	112	24	8½		454
...	...	...	...	...	...	...	...		457
..	...	50·5	...	...	124	26	8		455
...	..	...	...	...	...	...	..		
62·16	...	...	...	83·78	...	..	...		

44. *Centrifugal.*—Last year a regular sugar centrifugal 18 inches in diameter, geared by means of cog-wheels to a speed which was supposed sufficient for hand use was used to separate the molasses from the massecuite and produce centrifugal sugar. But the centrifugal was so difficult to turn at a speed approaching that required for sugar work that all attempts to use it proved a failure. This year an American laboratory hand-centrifugal with a 10-inch basket geared so that it could be run at a speed of about 1,500 revolutions was used. The maximum amount of massecuite which could be centrifugalled at one time was about 11 pounds, which gave roughly speaking about 7 pounds of sugar. But the work required to separate this small amount of sugar was so great that only a comparatively small quantity of the juice was boiled into massecuite, the greater part being used for jaggory. This was no doubt partly due to the fact that the centrifugal was not specially made for sugar work. But our experiments so far give little hope that hand centrifugals can be used to advantage in the production of sugar for the market. But the quality of sugar produced and its outturn when compared with jaggory as given in column No. 12 of the above table are very encouraging, indeed, and make it highly desirable to repeat these experiments as soon as possible with a larger plant driven by steam, or an oil-engine where fuel is very difficult to get.

45. The best sample of sugar given in the above table is No. 372. It is an extraordinary fine sample of raw centrifugal sugar and it received no special treatment except that it was washed in the centrifugal with about 7½ per cent of its own weight of water. In other words after all the molasses which could be easily separated by this small centrifugal had been got rid of, a little water was poured into the centrifugal when in motion and this in passing through the sugar removed the greater part of the remaining molasses. After this washing it was allowed to dry six or seven hours, and after that passed through a sieve to separate the larger grains from the smaller ones. This was done to give the sample a more uniform appearance. It was one of the samples sent to the Bellary Exhibition. In this sample there was less than a half per cent of glucose. Sample No. 371 representing the portion which remained on the sieve when preparing the sample No. 372, is of very nearly the same composition though a little darker in colour. But judging from the results of this year's work it is doubtful if the washing of raw sugars in the centrifugal pays.

46. The molasses separated from all the various samples of sugar was mixed together. After standing for over a month, some very fine-grained sugar separated out. This was removed by passing all the molasses through the centrifugal. The sugar obtained in this way is sample No. 393, which contains, as will be seen, a high percentage of glucose, and is somewhat similar to samples Nos. 452-454. The latter are so-called second sugars, that is, they were obtained as stated above by boiling down the molasses a little further and allowing it to stand for several weeks to permit the sugar to crystallise out of the tarry mass. The quantity of molasses was rather too small to permit of easy boiling. The entire mass charred for some unknown reason, and the second sugars produced were very dark on that account. 64¾ lbs. of molasses were boiled down to 52¼ lbs. second massecuite, in other words, only 19·3 per cent of water were evaporated. On an average 10 lbs. of second massecuite gave 4·83 lbs. of the second sugars. Or nearly 39 per cent of the original molasses was transformed into second sugars. When we add to this the 4 per cent of sugar separated out of the molasses on standing, we find that every 100 lbs. of the original molasses gave 43 lbs. of sugar. This figure forms the basis for calculating the quantity of second sugars entered in column No. 10. The figures in column No. 12 indicate the amount of centrifugal sugars (first and seconds combined) which were obtained from a quantity of juice which would have given 100 lbs of jaggory of the average composition of the jaggories produced this year, the analyses of which are given in Tables No. II and No. III. The remainder has been separated out in the form of molasses. This, as will be seen by referring to No. 456 and No. 457 in the table above, has 27·7 per cent of glucose and only 32 per cent of cane sugar. This is a very satisfactory result as it shows that but little more sugar-cane has passed into the molasses than the glucose contained in it. This is especially satisfactory for a first attempt. But it is to be hoped that the amount of glucose formed during boiling will be materially reduced in future experiments. This hope is justified by the results of the experiments of previous years. On the whole we have every reason to hope that with a comparatively small expenditure in machinery we will be able to very materially improve the sugar industry of Mysore. Whether it will be advisable or necessary to use pans heated by steam instead of by direct firing, future experiments will have to show.

47. *Milling of cane.*—It is of course in the juice of the sugar-cane in which the cane sugar (the substance for which the sugar-cane is cultivated) is found. The solid structures which form the vessels containing the juice are of comparatively little if any commercial value, but are generally used as fuel for boiling down the juice. It is however practically impossible to completely separate the juice from the solid structure called mark. Even the best mills leave a small proportion of the juice with the mark. This mixture of mark and juice left in it after milling is called begasse, or in some countries meggasse. Begassee from the most powerful nine-roller mills still contains about 5 per cent or a little more of the juice. The proportion of the juice left in the Begasse is of course less when the mills are large and the pressure great. But in addition to the greater pressure which can be exerted by large mills, these large nine-roller

mills have the additional advantage that the cane is sprinkled with water between each set of three rollers. The juice being diluted in this way, the portion left in the cane is also diluted and contains less sugar than it otherwise would. The begasse is similar to a sponge soaked in juice of sugar-cane and squeezed dry. The harder it is squeezed the larger the proportion of the juice which will run out. If it is afterwards soaked in water and again squeezed to the same extent, more diluted juice runs out; and if this process is repeated often enough, the sponge will finally be practically free of juice. By this method of sprinkling the cane with water as it passes from one set of rollers to the other much more juice can of course be extracted than without it. But in addition to the size and construction of the mill, the amount of mark the cane contains will materially affect the amount of the juice lost in the begasse. A small sponge will retain a much smaller weight of liquid (or juice) than a larger sponge subjected to the same pressure. Sugar-cane containing little mark is, therefore, other things being equal, more valuable than cane containing much mark; and this must be taken into account when judging the efficiency of a sugar-cane mill.

TABLE No. V.

Showing percentage of juice left in begasse (refuse cane) when milling with ordinary three-roller iron sugar mill.

Serial No. of juice	Weight of cane used, lbs.	Weight of juice obtained, lbs.	Percentage of extraction (1)	Weight of begasse (2) lbs.	Percentage of extraction (4)	Total solids in juice	Moisture in begasse	Percentage of mark (4) in begasse	Percentage of juice left in begasse
1	2	3	4	5	6	7	8	9	10
281	343¾	200½	58·0	137½	602	20·9	59·06	10·08	31·9
283	414¼	252	60·8	148	64·3	21·0	56·51	10·17	28·4
285	431	259½	60·0	162½	62·3	21·0	56·89	10·35	30·3
289	451	276½	61·3	166	63·2	20·2	56·70	10·66	29·3
291 (5)	472	289½	61·3	170	64·0	20·0	59·59	9·18	29·5
292	450½	224	47·7	215	52·3	19·6	55·65	14·69	33·7
294	413¼	283½	68·6	120	71·0	20·6	55·80	8·62	22·3
296	406	262½	64·5	137½	66·2	19·9	59·55	8·69	28·5
298	178	128	71·9	46¼	74·1	20·6	57·41	7·17	20·2
300	467¾	284½	60·8	179¾	61·6	21·1	51·61	13·28	29·0
302	428½	280	65·3	141	67·1	21·1	56·73	9·24	26·1
304	454	284¾	62·3	162¼	64·5	20·9	51·26	12·50	26·3
306	473	314½	86·4	149½	68·4	21·3	53·75	10·02	24·0
307	472	311½	66·0	151¾	67·8	20·1	55·50	9·82	24·8
309	370½	251	67·7	111½	70·0	20·7	57·63	8·20	23·7
311 (6)	433¾	285	65·7	139	68·0	20·8	53·86	10·24	24·2
313	494	282½	57·2	200½	59·4	17·9	47·64	17·04	28·4
316	379½	253½	66·8	117½	69·0	20·6	51·40	10·93	22·5
318	377¾	253¾	67·1	118	78·8	19·8	56·04	9·06	24·4
322	353	225	63·7	120	66·0	20·4	52·59	11·54	25·4
324	386	269½	69·2	118	69·4	19·6	53·75	10·15	22·8
329	431¾	283½	65·6	136	68·5	19·9	52·04	11·04	23·0
331	454	298½	65·7	148	67·4	18·9	52·30	11·56	23·7
332	416½	266	63·9	137½	67·0	19·0	53·95	11·02	24·7
336 (7)	469½	314	66·8	138	7·06	18·6	53·71	10·09	21·6
395 (7)	479	314	65·5	153½	67·9	17·0	60·90	8·55	25·8
397 (7)	446	286	64·1	147½	66·9	17·7	59·8	9·04	26·4
399 (7)	484	318	65·7	152	63·6	17·4	58·5	8·75	24·8
401 (7)	510	328	64·3	172½	66·2	17·5	60·3	8·75	27·4

TABLE No. V.—*concld.*

Serial No. of juice	Weight of cane used, lbs.	Weight of juice obtained, lbs.	Percentage of extraction (1)	Weight of begasse (2) lbs.	Percentage of extraction (3)	Total solids in juice	Moisture in begasse	Percentage of mark (4) in begasse	Percentage of juice left in begasse
1	2	3	4	5	6	7	8	9	10
403 (7)	529	342	64·6	173	67·1	17·9	60·5	8·60	26·4
405 (7)	418	274	65·5	128	69·4	17·1	58·2	9·12	23·6
407 (7)	408	269	95·9	131	67·9	18·5	62·0	7·68	26·8
409	537	340	63·3	189	64·8	15·1	59·3	9·71	28·2

(1) Extraction calculated by dividing the weight of juice by the weight of cane.

(2) Begasse is the refuge cane coming out of the mill.

(3) Extraction calculated by dividing the weight of begasse by the weight of cane. This is not as accurate as the extraction given in column 4 as the begasse loses weight very rapidly owing to the large surface from which the juice can evaporate.

(4) Mark is what remains when *all* the juice is removed from the sugar-cane.

(5) The cane from which juice No. 292 was obtained was very short in the joints. This accounts for the high percentage of mark and the low extraction.

(6) The cane from which the juice No. 313 was obtained was a hard thin variety known as Chinikabbu.

(7) The begasses corresponding with the sample of juice No. 395 and succeeding samples were sampled, weighed, and dried more rapidly than the others, and the figures given in the columns 9 and 10 for these samples are therefore more accurate than the others in the same columns.

48. The mill used in the experiments this year was a locally made three-roller iron mill. The rollers are placed vertically and are of equal size—9 inches long and 6½ inches in diameter. The figures given in column 4 and column 6 ought to be the same if both were absolutely accurate. But the refuse cane or begasse loses weight very quickly owing to the juice still retained in it evaporating very quickly, for it is spread out in a thin layer over a large surface. As the begasse is really heavier immediately after it is milled than a little later when it is actually weighed, the results calculated from the figures thus obtained give a little higher extraction than that which is actually obtained. But the juice in the pails also evaporates a little before weighing, though not nearly as much, as that in the begasse; the results obtained when dividing the weight of the cane into the weight of the juice as given in column 4 are therefore not quite accurate either. They are a little too low. The truth is somewhere between these two results though nearer those given in column No. 4 than those recorded in column No. 6 in Table No. V above. Nevertheless the latter results are taken for calculating the results given in column No. 10, and these results are therefore too low in exactly the same proportion as the figures in column No. 6 are too high. There is therefore actually a little more juice left in the begasse (refuse cane) than these figures indicate. The mill was set much closer than is usually done by the raiyats. (The begasse was very much cut up when it came out of the mill and was in small pieces so that all of it had to be carried in baskets from the mill to the scales.) And the juice left in the begasse in actual practice is therefore more than it was in these experiments. With these small iron mills which are no doubt a great improvement on the old wooden mills, there is therefore a loss of ¼ to ⅓ of the juice originally contained in the cane. This is a loss much greater than was anticipated. For some time to come the best mills, those extracting all but five per cent to ten per cent of the total juice of the cane, are both too large and too expensive to be used in Mysore except by large firms having a large area under sugar-cane; for they can mill from 500 to nearly 1,000 tons of cane a day and could easily mill 1,000 acres of the best cane in a season But there is a very large range in sizes of sugar-cane mills between these giants, and the so-called improved sugar-cane mill used in Mysore. And with a mill very much smaller and cheaper than the largest mills in use elsewhere a very much better extraction should be possible than the "improved mills" in Mysore are able to give. Next year it is hoped we shall be able to make experiments with a three-roller mill driven by an oil-engine having rollers eighteen inches long by twelve inches in diameter capable of crushing one ton of cane per hour. The rollers lie horizontally. Such a mill is being imported for Mr. Krishnaiengar, Inamdar of Oorgahalli, and experiments will be made with it after it arrives.

49. *Deterioration of cane after cutting.*—The general impression in cane-growing countries appears to be that cane deteriorates but little after being cut for a day or two at any rate. In Louisiana cane is sometimes preserved in pits for a month or more after cutting for seed. Cane sent for some distance to central factories must of course be cut some considerable time

before being milled, especially if it is sent, as is sometimes done, for fifty miles or so. And when considering the advisability of starting Central Sugar Houses in India, a very important question is to find out how long cane will keep and how far it may be sent without serious loss. For the purpose of studying this question the canes from one plot were divided as evenly as possible into twenty samples. Of these, two were analysed soon after being cut. But as there appeared no special reason for hurrying and as the sorting and sampling took some time, these samples had been cut for some hours—probably four or five—before being analysed. The other samples were analysed from two days to one month later. Some samples were not topped, to see if this would have any effect on their keeping quality. Below are given the results of the analyses together with the dates on which they were made.

TABLE No. VI.

Table showing the effect of cutting cane before milling it. Analysis of juice of sugar-cane cut April 22nd, 1905, and kept for various lengths of time :—

No.	Date	Weight: Original lbs.	Weight: When analysed lbs.	Sucrose ; per cent	Glucose ; per cent	Total solids per cent	Calculated to original weight taking ten per cent mark in cane: Sucrose ; per cent	Calculated to original weight taking ten per cent mark in cane: Glucose ; per cent	Calculated to original weight taking ten per cent mark in cane: Total solids ; per cent	Remarks
1	2	3	4	5	6	7	8	9	10	11
338	22 IV 05	26	26	16·40	·87	17·70	16·46	·87	17·7	
339	22 IV 05	25¼	25¼	17·30	·87	18·60	17·30	·87	18·6	
340	24 IV 05	26¼	25½	13·75	3·67	18·60	13·16	3·51	17·8	
341	26 IV 05	26½	24¼	14·35	5·20	19·20	12·94	4·69	17·7	
343	28 IV 05	24¾	21¾	13·40	6·25	20·30	11·58	5·39	17·9	
344	28 IV 05	...	..	15·10	5·81	22·50	...	...	...	Tops left on.
345	1 V 05	24	20	13·35	7·30	22·00	10·87	5·94	17·9	
346	1 V 05	24¾	20½	13·35	7·10	21·70	10·83	5·76	17·6	
347	3 V 05	23	18¼	13·70	7·60	22·20	10·53	5·87	17·1	
348	5 V 05	26	22	13·45	8·50	22·70	11·15	7·05	18·8	
350	7 V 05	21	15½	13·90	8·60	23·80	9·90	6·10	16·9	
351	7 V 05	24	18¼	13·35	8·80	23·70	10·07	6·64	17·9	
352	9 V 05	26½	20	14·70	8·80	24·10	10·70	6·41	17·5	
353	12 V 05	22½	17	12·70	9·40	24·20	9·26	6·85	17·6	
354	12 V 05	26½	19½	14·15	9·20	24·80	9·82	6·38	17·2	
355	15 V 05	24½	16¾	12·95	10·87	25·50	8·38	7·03	16·5	
356	17 V 05	24½	16¾	12·25	10·90	25·40	7·93	7·05	16·4	
357	17 V 05	24¾	17	12·70	10·10	23·90	8·30	6·61	15·6	
358	19 V 05	24½	16¾	15·05	10·50	25·40	6·80	6·79	16·4	
359	25 V 05	37½	23½	7·80	12·80	23·70	4·57	7·50	13·8	Tops left on.
360	25 V 05	25½	15½	12·30	11·60	26·60	6·95	6·55	15·0	Do

Samples Nos. 338 and 339 have not quite the same composition though they are similar samples. From data found in the analyses of the succeeding samples, No. 338 may be taken to very fairly represent the average composition of all the samples on that date. No. 339 is certainly above the average in sucrose and total solids. But it is especially the glucose which we have to consider in this set of experiments. Both samples contain, as will be seen, ·87 per cent of this constituent. As the samples were not milled immediately after they were cut, it is just possible that some change may already have taken place in them when they were analysed; for ·87 per cent is rather more glucose than it was expected to find. But as in the case of the experiments made to test the keeping qualities of juice, practically no change took place in some of the samples during the first nine hours. It is not likely that much change has taken place in these samples of cane before the analyses were made, for it is natural to assume that cane

will keep longer than the juice after it has been extracted. In two days' time the change in the cane is however very great. As will be noticed by comparing columns Nos. 3 and 4, there has been some loss in the weight of cane, and the percentage of glucose and the sucrose will, owing to the drying out of the cane, of course appear to be higher than it would have been if the cane had not lost some of its water. But this drying has been allowed for in the results given in columns Nos. 8, 9 and 10. These give, therefore, the actual change which has taken place, for in them the changes produced by the simple drying out of the cane has been eliminated. The change in the first two days has been very much greater than in any of the succeeding two days. Why this should be the case is at present difficult to understand. There is an increase of nearly three per cent in the glucose and a decrease of a similar amount in the sucrose. This denotes a very serious loss indeed, as it will probably represent the loss of over one-third of the total sugar if the product is to be sugar and not jaggory. But of course these experiments will have to be repeated a number of times before they can be taken to represent the actual state of affairs. During the first twenty days or more after cutting, the loss in sucrose was about balanced by the gain in glucose, so that the total solids remained very nearly the same for this period of time. After that the total solids begin to decline showing that other changes than the simple transformation of sucrose into glucose had taken place. Leaving the tops on the cane has apparently not made much difference in these experiments. But that part of the question has not received a fair test this year. The results of these experiments as a whole have indicated that there probably is a very much greater loss by cutting the canes a day or more before milling than is generally believed. The experiments must be repeated as soon as possible, and the time allowed to lapse between the first four of five analyses must be very much shorter than was the case this time.

50. *Deterioration of juice on keeping.*—When visiting the Refinery at Samalkot in January last, I was asked if in my opinion it would be safe to ship carefully limed juice in properly sterilized iron drums for some distance to the factory. As this question is one of general interest, the following experiments were made to test this point. Juice which was protected as carefully as is possible in ordinary milling practice from being infected with ferments was, after being analysed, set aside in clean glass vessels. Half of it remained unlimed, the other was limed as described in para 34 on page 9 of this report. After a specified time both samples were analysed again. The results are given in the following table :—

TABLE No. VII.

Table showing the amount of fermentation of cane juice, as indicated by an increase in the percentage of glucose, on standing.

No. of juice	Treatment	Analysed after standing hrs.	Glucose per cent	Date of analysis
318	Unlimed	Fresh	·67	April 18
	Do	7	·82	Do
	Limed	7	·75	Do
324	Unlimed	Fresh	·80	Do
	Do	6	·91	Do
	Do	20	2·9	Do 19
	Limed	6	·83	Do 18
	Do	20	6·2	Do 19
332	Unlimed	Fresh	·73	Do 20
	Do	6	1·10	Do
	Limed	6	·74	Do
458	Unlimed	Fresh	·61	Do 26
	Do	14	2·04	Do 27
	Do	19	3·03	Do
	Limed to neutrality	14	1·93	Do
	Do	19	3·50	Do
	Over-limed	14	·99	Do
	Do	19	3·05	Do

51. Taking these results as a whole, there appears to be a slight tendency on the part of limed samples to keep better than the unlimed juice. But as far as these results go, this pre-

serving action is not sufficient to justify any one to rely on it in helping to prevent the juice from fermentation. Further experiments in this direction are given in the following table :—

TABLE No. VIII.

No. of juice	How treated	Fresh juice; glucose per cent	Analysed after standing						Date
			Three hours; glucose per cent	Six hours; glucose per cent	Nine hours; glucose per cent	Thirteen and one-fourth hours; glucose per cent	Seventeen and one-fourth hours; glucose per cent	Nineteen and three-fourth hours; glucose per cent	
452	Unlimed	·54	·56	·61	·61	...	...	...	April 26
453	Limed to neutrali ...	·54	·54	·58	·61	...	.	...	Do
454	Over-limed	·54	·54	·56	·61	...	...	...	Do
455	Unlimed	·37	...	...	...	·42	·62	1·00	May 8 and 9
456	Limed to neutrality ...	·37	...	...	...	·40	·57	·80	Do
457	Over-limed	·37	...	...	...	·37	·44	·61	Do

In these experiments it was desired to follow the changes taking place in the juice for the best part of a day. To the unlimed and limed samples were added a third into which more than double the amount of lime used for the ordinary "limed" sample had been put. This is described as "over-limed." The first set of three samples were milled one morning and analysed every three hours. The next set of three samples Nos. 455, 456 and 457 were milled in the evening, analysed immediately and allowed to stand overnight. They were analysed again next morning after standing 13¼ hours, 17¼ hours and 19¾ hours. The results show a tendency for the overlimed sample to keep better than the others. But in none of the cases has fermentation been entirely stopped for even twenty hours, and it is doubtful if as satisfactory results as this could be got on an average in general practice. But the experiments are sufficiently encouraging to justify their being continued.

52. *Resume.*—On the whole this year's experiments with sugar-cane and with its manufacture indicate that there is a danger in sending sugar-cane or its juice for distances requiring more than a few hours in transit. The results when making raw centrifugal sugar are so encouraging that it appears likely that even comparatively small houses are likely to help the sugar industry very much.

53. Regarding the opinion that jaggory gets darker in colour the heavier the juice is limed, the experiments show that when the juice is in sufficiently limed the jaggory gets darker with the addition of lime, but that a sufficiently limed sample of juice gives a jaggory lighter in colour than one from juice limed to one-half this extent. The following directions given last year deserve repetition :—

"When boiling jaggory, the greatest care should be taken—

(1) to lime the juice to neutrality as indicated by litmus paper,

(2) to use no earthenware pots,

(3) to wash the mill and all (metal) pots and vessels at least once a day *before* stopping work,

(4) to boil the juice as soon after it is milled as possible,

(5) to see that the rollers of the mill are set as close together as possible," and, added to this,

(6) mill the cane as soon after cutting as possible.

COFFEE.

54. *Analyses.*—On page 10 of the Fourth Annual Report are given the results of the analyses of six samples of coffee in which it appears that in a general way the price paid for the coffee decreased with the specific gravity, the nitrogen, phosphoric acid and the potash. On page 11 is stated, "So far as the results go they are very satisfactory indeed. But the number of analyses is much too limited for drawing any conclusions." In the Fifth Annual

Report, pages 17 to 24, the continuation of that work has been reported. Fifty-one widely different samples collected by the United Planters' Association of Southern India were tested in regard to their specific gravities. These results bear out the results obtained with the specific gravities the previous year. But the further analyses of the samples indicate no relation existing between the price realized in the London market and the contents of either nitrogen or phosphoric acid or potash, and the sentences quoted above from the Fourth Annual Report have proved amply justified. As the analyses are not quite finished, as some further determinations of some of the organic substances of the coffee are to be made if time permits, and as the analyses so far made are not of any immediate practical value in determining the quality of coffee, the detailed results will not be published until the work has advanced further than it has at present. It is sufficient for the present to note that the total nitrogen, total phosphoric acid and total potash are not an index of quality.

55. *Manurial experiments.*—On pages 6 to 9 in the Fourth Annual Report are given the results of plot experiments with manures on coffee. On experimental fields No. 1 and No. 2 the experiments have been continued for another two years with practically the same results. In both fields an unmanured plot still heads the list when taking the average of all the years the experiments have been going on. Mr. Denne and Mr. Harris who have conducted, very carefully, the experiments referred to above, have kindly consented to continue them. The amount and nature of fertilizers used, the arrangement of the plots and the results obtained up to 1903, are given in the report referred to above; and as the results since 1903 only serve to confirm the previous results, it is not necessary to give them here. They will, however, be published at some future time. The results obtained so far simply indicate that on these plots the manures applied have not acted. It is simply a coincidence that in both cases an unmanured plot has given the best average results. In Mr. Harris's field which contains two unmanured plots the average of the second of these plots is practically the worst. It is fortunate, however, that in all the experiments an unmanured plot heads the list. The results could not have been interpreted nearly as easily if the unmanured plots had given on an average a result which in its turn had been an average, and they might have been absolutely misleading if they had happened to give as persistently the poorest returns as they happened to have given the best. But if these results are taken to indicate that on these particular plots all the manure applied since the experiments were begun have for some at present unknown reason, failed to give any practical results the interpretation is very safe and very conclusive. As these results have been obtained on two fields it is not unreasonable to suppose that there is a chance of a similar thing happening on other fields.

56. But experiments from only two experimental fields even when conducted for five years cannot of course give *conclusive* results. These experiments cannot therefore be taken to show that coffee has been over-manured in the past and do not prove that if these fields had not been manured at all for five years, the results would have been as good as they would have been if they had been very heavily manured. But they *do* indicate that there is still something to learn about the manuring of coffee, and that our present treatment is not necessarily the most economic, and they state as plainly as they can that any one anxious to save unnecessary expenditure, would do well to join in this line of experiments to see if it is not possible to reduce expenditure in manures. That we cannot indefinitely crop any piece of land without returning to it at least part of the plant food removed by the crop appears reasonable to all of us. But if we consider the comparatively small amount of plant food removed in 5 cwts. of cleaned coffee, the comparatively rich nature of the soil required for coffee, the fact that at Rothamsted a continuous crop of wheat has been grown on one field for considerably over half a century and is still producing a respectable crop, and that the only actual experiments made with manures on coffee (experiments where the crop from each individual manured plot has been weighed and compared with that produced on a similar adjoining plot which has not been manured) have shown no marked result in favor of the manures applied, it is, I believe, time to be serious about manurial experiments with coffee, and make sure that the good results we believe to have noticed after the application of some one or other manure applied are really due to the manure used and not traceable to some other unexpected cause. For if it were possible to reduce expenses without injuring in any way the returns, the sooner we knew it the better. I therefore strongly urge that a large number of manurial experiments be started with coffee and continued for a considerable time. It is waste to apply more manure than necessary, especially manures like poonacs which are not retained very long by the soil. On the other hand it would be suicidal to manure less than required; and as practice, no matter how long established, does not necessarily prove a point unless accompanied by experiments, we must make all the experiments possible to test, and if possible, improve our practice. It is reasonable to suppose that in the experiments now carried out, the unmanured plot will drop behind some time. But the fact that this "some time" has not yet arrived ought to make every one interested in coffee anxious to determine whether this is simply due to an accident, or local circumstances, or is caused by some generally existing conditions.

FERTILIZERS.

57. In addition to the analyses made this year, the maximum, minimum and average composition of some of the more important fertilizers, as found in this Laboratory during previous years, has been given to enable those interested in the subject to get a clearer idea of the range in composition which may be expected in those fertilizers in this part of India. The

fertilizers analysed this year were, with the exception of ashes, principally analysed to enable firms dealing in fertilizers to give a guarantee with their fertilizers as to their composition.

TABLE No. IX.

Poonacs.

No.	Substance	Nitrogen analyses of previous years			Analysis, 1904-05		Location
		Average percentage	Minimum percentage	Maximum percentage	Nitrogen percentage	Phosphoric acid percentage	
	White castor	6·53	5·56	8·69	..	...	
55	Do	...	...	...	4·76	...	
69	Do	...	...	...	6·35	2·62	Bangalore
	Kurdi	4·83	3·92	6·43	..	...	
206	Do	...	...	...	8·30	...	
207	Do	...	...	...	4·86	...	Hubli
	Neem (Melia Azadi)	5·01	4·43	5·99	...	...	Do
58	Do	...	...	...	4·12	...	
	Honge (Pongamia glabra) ...	3·81	3·59	4·01		...	
70	Do	...	...	...	3·88	·99	Bangalore
	Ippe (Bassia latifolia)	2·97	1·80	4·14	...	...	

58. *White castor.*—No. 69 is a white castor poonac taken from a large heap, and as might be expected represents fairly well an average sample of good average white castor. The firm in question excluded as far as possible all samples which appeared adulterated. Sample No. 55 is, I believe, also taken from, "bulk," but is, as will be noticed, very poor, having a lower percentage of nitrogen than any other sample analysed in this Laboratory before. It came from outside of Mysore and indicates the necessity of consumers insisting on a guarantee as to composition.

59. *Kurdi* Samples Nos. 206 and 207 were simply analysed to check the results obtained in one of the laboratories recently established, to enable its owner to guarantee the composition of the fertilizers sold by him. Sample No. 206 is so abnormally rich in nitrogen that I feared there was something wrong with the determination, but it was all right. The minimum percentage of nitrogen given for Kurdi is 3·22 notwithstanding that an old sample of unknown source gave less than 3 per cent of nitrogen. In no other fertilizer does there appear to be so much range in quality as in Kurdi, or safflower cake.

60. The figures connected with the other varieties of oil-cake given above, require no special mention.

61. As to the difference in the intrinsic value of different samples of oil-cakes of the same kind, I refer to page 24 of the Fifth Annual Report, page 15 of the Faurth Annual Report and page 12 of the Third Annual Report of this Department.

62. *Bone and fish.*—The following table giving the composition of dried fish and bone meal require no special comment. A variety of fish called bungara gave the maximum results, and a small variety of fish called by the sender sardines gave the poorest returns. The sample of bone meal giving the poorest results was undoubtedly adulterated.

TABLE No. X.

Bone and fish.

No.	Substance	Results of previous years						Analysis, 1904-05		Locality
		Nitrogen			Phosphoric acid					
		Average	Minimum	Maximum	Average	Minimum	Maximum	Nitrogen	Phosphoric acid	
	Dried fish ...	6·01	3·96	8·72	5·03	1·73	7·51	...	...	
56	Do ...	...	...	...	...	...	...	4·48	4·53	West Coast
57	Do ...	...	...	...	...	...	...	6·33	3·61	Do
	Bone meal ...	3·58	2·52	4·04	22·38	18.62	23·36	...	...	
71	Do ...	...	...	...	...	...	...	3·77	22·53	Bangalore

FERTILIZERS OTHER THAN THE ABOVE.

63. The number of inquiries received as to whether the acid sulphate of potash formed as a by-product at the Cordite factory at Wellington could be used as a fertilizer, shows that there is a strong desire to make use of any substance likely to be valuable for manurial purposes. Unfortunately the small percentage of lime found in most South Indian soils makes it highly probable that this acid sulphate of potash is not likely to be of much value as a manure. It is more likely to be a poison to plant life. But so far no experiments have been made with it to test these points. Probably if mixed with an equal quantity, or more, of freshly burned lime, it would do very well as a manure; but as lime is rather expensive and as its value as an indirect fertilizer would, to a very large extent, be lost if used in this way, this recommendation has not found favor, and no experiments have, as far as I know, been made to see if such a mixture would be satisfactory. Messrs. Stanes & Co. of Coimbatore have mixed this acid sulphate with bone meal in the hope that the acid sulphate would act on the bone in something like the same manner as sulpheric acid would do. But as both the acid sulphate and the bone meal were in the form of a powder, they did not have much chance to react on each other. However from the analysis of this mixture it is evident that some reaction has taken place, for in this mixture were found 8·09 per cent of phosphoric acid soluble in a neutral solution of ammonium citrate (the re-agent used for determining the "available phosphoric acid" in fertilizers), and as owing to the increase in bulk due to the addition of the acid sulphate of potash, the total phosphoric acid was reduced from about 23 per cent to 13·58 per cent. This mixture had 59·57 per cent of its total phosphoric acid in an available form. As none of the untreated samples of bone meal which had been used for this mixture accompanied it, another sample of bone meal was analysed and found that in it 27·16 per cent of the total phosphoric acid were in an available form. If the two samples of bone are nearly alike, and it is reasonable to suppose this, there can be no doubt that the acid sulphate, even in the form of a powder, had some action on the bone meal; and as the injurious effects of the acid sulphate are reduced in exactly the same proportion as the sulphate acts on the bone meal, it is quite possible that if the acid sulphate is applied in the form of a concentrated solution to finely powdered bone meal, its injurious action as a fertilizer may be turned to good account in making the bone meal more available. Messrs. Stanes & Co. of Coimbatore have kindly promised to make this experiment, and the produced sample will be analysed and some pot-culture experiments made with it in this Department.

64. *Trichi phosphate.*—As a large number of inquiries were received in regard to this phosphate, a sample was analysed notwithstanding that, as it is a rock phosphate, it is not likely to be of much use as a manure unless converted into superphosphate. It was ground very fine and practically all passed through the standard (100 meshes to an inch) sieve. But as will be seen from the table given below, practically none of the phosphoric acid was soluble in a neutral solution of ammonium citrate, and therefore judged by the European and American standard, practically none of it is available.

65. *Bone char.*—The bone char, a refuse from the sugar refinery, contained a comparatively large amount of nitrogen for a substance of this kind. But as bone char is considered to be practically inert unless treated with sulphuric acid and transformed into super-phosphate, the amount of nitrogen cannot make it a fertilizer which could be recommended. Moreover the nitrogen contained in it is likely to be itself very inert.

66. *Aloe fibre refuse.*—A sample of dried aloe fibre refuse sent from the Shevaroy Hills was found to contain 1·64 per cent of nitrogen. This is not sufficient to justify it being carried long distances when in tended to be used as a fertilizer. It is not far short in nitrogen of the poorest of sample of ippe poonac analysed here. But as it is fairly bulky and possibly the nitrogen in it is not quite as available as that in poonacs, it cannot be considered as a commercial fertilizer. Its bulky pithy nature are, however, likely to make it an excellent mulch where such can be applied. And as a mulch is in itself of great value, the aloe fibre refuse will have to be considered as a useful by-product of the aloe fibre industry if used in the neighbourhood of the factory.

67. *Ashes.*—Considerable quantities of wood ashes are used annually for manurial purposes. These are generally prepared specially for that purpose by burning brushwood; and the heat produced by the burning is not utilized in anyway. Some of these ashes are, however, so poor in potash that it cannot possibly pay to make them even if the wood is value-less and there is little other work for the coolies at the time. Nos. 60 and 62 in the following table are of this nature. Both of them contain less than 1 per cent of potash soluble in hydrochloric acid, and of this amount not much more than half is soluble in boiling water, and therefore readily available. A ton of these ashes would therefore be worth less than Rs. 3. Samples Nos. 30 and 32, which are also produced from mixed woods, are very much better in quality, being more than twice as valuable; but even these are low in potash. Both samples Nos. 63 and 64 are, however, valuable samples of ashes. But the best of these analysed thus far is No. 33, a sample of bamboo ashes received from Coorg. But, strange to say, probably owing to the light weight of these ashes, they have generally been considered to be of but little value. Some other wood ashes such as Lantana will be analysed soon. If their percentage of potash should happen to be high it may help in solving the problem of stopping the Lantana invasion. It is a pity, however, to see wood other than Lantana burned solely for the sake of the ashes.

TABLE No. XI.

Ashes and miscellaneous fertilizers.

No.	Substance	Nitrogen	Phosphoric acid	Phosphoric acid soluble in amonium citrate	Potash	Potash soluble in water	Lime	Loss on ignition	Insoluble residue
	Bone meal	4·04	23·34	6·34	...	...	...	...	...
188	Bone meal treated with ab out its own weight of dry acid sulphate of potash.	..	13·58	8·09	...	...	..	..	...
204	Trichi ph osphate ...	...	25·51	0·38	...	...	43·86	...	...
37	Bone char	1·21	27·80	...	...	...	...	...	...
31	Crude saltpetre	3·63	...	...	...	16·71	...	...	...
54	Refined do	12·95	...	...	...	39·58	...	...	...
187	Aloe fibre refuse	1·64	...	...	...	...	...	...	...
29	Ashes	...	1·15	..	...	...	11·51	26·90	45·54
60	Ashes, mixed wood ...	...	...	...	·93	0·61	..	15·54	...
62	Do do ...	...	...	...	·78	0·40	...	..	...
63	Do bratty	...	...	...	4·82	2·53	...	...	...
64	Do chetty burners ...	...	...	...	3·47	1·90	...	...	...
30	Ashes, mixed wood ...	...	0·57	...	2·32	...	17·43	20·24	44·50
32	Do do ...	...	1·45	...	1·97	...	29·04	28·94	24·40
33	Do bamboo	...	2·54	...	5·40	...	...	...	...

MISCELLANEOUS.

68. *Purifying water with alum.*—At the request of the Deputy Chief Engineer, some observations were made in regard to the amount of alum required to clear the water of the Hessarghatta tank. It is of course difficult to state exactly when the settling of the suspended matter began and there is also some difficulty, in a simple observation like this, to find out when the water is practically clear, as a considerable quantity of the fine suspended matter clings to the side of the glass vessel. But for practical purposes the figures given below are accurate enough, and may be of help to those wishing to clear water for domestic purposes. The water was very turbid. But two grains per gallon or about one ounce for 200 gallons was all that was required to practically clear the water in seven hours and was almost as effective as four times that quantity; but it is the minimum quantity which gave good results. One and a half grains per gallon proved to be inefficient unless the water could be allowed to stand quietly for a day or more.

TABLE No. XII.

Alum grains per gallon	Began to settle in hours	Practically clear in hours
8	2	5
5	3	5
4	3	5
3	3	5
2	3	7
1½	5	27
1	96	...
0	...	...

69. *Salt.*—Two samples of sea salt were analysed. The one contained 84 per cent of salt, the other 92 per cent. The poorer sample contained, in addition to the salt 1·64 per cent of magnesia, and some lime, potash and sulphuric acid (of course all combined). The better sample contained 0·77 per cent of magnesia, and of the other impurities mentioned above, it contained about half the quantity found in the poorer salt. The remainder of the impurities were sand and other insoluble matter and water.

70. *Famine food.*—Twenty-two other samples of famine foods were sent in, and in all of them the nitrogen has been determined. On the average the nitrogen content is a little higher than that of those analysed last year though both the highest and lowest percentage of nitrogen is very much lower than last year. The highest was 2·70 per cent found in a sample of

Kannay leaves sent by the Amildar of Malur; but there were several other samples nearly as rich. The poorest contained only 0·05 per cent of nitrogen. It was a sample of Godirasadagadde flour sent by the Deputy Commissioner of Shimoga. But no other sample received had anything approaching this low percentage of nitrogen.

71. As samples of famine foods are still being sent in to the Laboratory, and as some other constituents, for example, crude fibre, fat or ether extracts, and amide nitrogen, have to be determined to judge of the food value of these famine foods, the results obtained this year and those already published last year on pages 26-28 of the Fifth Annual Report will be published together when the analytical work regarding the nutritive value of these foods has been finished. If some senior officer in the Mysore service well acquainted with these famine foods and the peculiarity of the people who might have access to these foods in time of famine could be deputed to write a bulletin on these foods in conjunction with the Agricultural Chemist when the analytical work is finished, that bulletin would doubtlessly be of much more value than the bare statement of the analytical results would make it.

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